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Stick-slip friction of polymer gels with controlled asperities

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It is well known that surface asperities at fault interfaces play an essential role in stick-slip friction. There have been many laboratory experiments conducted using rocks and some analogue materials to understand the rolls of asperities and the underlying mechanisms. Among such materials, soft polymer gels have great advantages of creating asperities with desired shape and slowing down propagating rupture front speed as well as shear wave speed: it facilitates observation of the dynamic rupture behavior. However, most experiments were done with bi-material interfaces (combination of soft and hard materials) and there are few experiments with an identical (gel on gel) setup. Furthermore, there have been also few studies mentioning the link between local asperity contact and macroscopic dynamic rupture behavior.
In this talk, we report our experimental studies on stick-slip friction between gels having controlled artificial asperities. We show that, depending on number density and configuration randomness of the asperities, the stick-slip behavior greatly changes: when the asperities are located periodically with optimum number densities, fast and regular stick-slip motions occur, while slow and heterogeneous slip behavior is observed for samples having randomly located asperities. We discuss the importance of low frequency (large wavelength) excitation of the normal displacement contributing to weakening the fault interface. We also discuss the observed regular to slow slip transition with a simple model.